Defense Technical Information Center Compilation Part Notice

ADP010961

TITLE: New Approaches to Processor Lifecycle Management

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: Strategies to Mitigate Obsolescence in Defense Systems Using Commercial Components [Strategies visant a attenuer l'obsolescence des systemes par l'emploi de composants du commerce]

To order the complete compilation report, use: ADA394911

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, etc. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:
ADP010960 thru ADP010986

New Approaches to Processor Lifecycle Management

October 2000

Duncan Young
DY 4 Systems Inc.
333 Palladium Drive,
Kanata, Ontario
K2V 1A6
Canada

Summary: There is a growing discontinuity between the semiconductor supply chain and the requirements of military programs to support equipment in the field for long periods of time - typically for 15 years or even longer. This isn't news any more, it was a natural consequence of the COTS Procurement Initiatives and the shift in focus of the semiconductor supply industry, started early in the 1990s, to much larger and ever more lucrative markets. While COTS was embraced enthusiastically at the outset by our community, some of the real issues are only now beginning to come home to roost, tainting COTS as a standard for doing business. This is apparent through the performance of some suppliers, particularly in their attitudes and commitment to obsolescence and real lifecycle management.

This paper has been written from the perspective of a COTS, open architecture, board-level supplier and is intended to provide insight and guidance for the selection and management of a supplier when considering various options of overall system lifecycle management.

COTS: definition: *"Commercially available products, available from a published catalog and price list. The supplier will have absorbed the IR&D costs and will own the IPR. Performance of the product is as stated in the supplier's specifications"*. This pure definition makes no claims as to the ruggedness of the product, nor to its suitability for deployment in the final, end-use application. The integrator must make the selection of product and supplier based on his own and the supplier's performance specifications. COTS procurement is not descriptive of product quality or fitness for purpose, it is a ***process*** which must be adopted to achieve the true benefits of COTS.

Program Phases: Systems integrators ideally need to maintain technology continuity between the various phases of their programs, from ATD (Advanced Technology Development), through EMD (Engineering Manufacturing Design), LRIP (Low Rate Initial Production) and Production. COTS products such as VME have had a real and visible impact on reducing the length of these cycles, particularly for non-mission critical or benign environment programs where the jump has been made, in some cases, directly from ATD to full production and deployment. However, the life of individual components used in a typical VMEbus product, often as short as 18 to 24 months today, may not be long enough to support even two consecutive phases of program development.

Lifecycle Management, Early Commitment is Required: Given the obsolescence challenges, total Product Lifecycle Management is the only way to effectively bridge the widening gap between customers' and end-users' needs and our industry's ability to deliver effective and maintainable solutions. Lifecycle management is just what it says. It starts from inception of a new product idea and doesn't end until the last customer has sent his last product back for repair. The first step starts with new product design by implementing a Component Selection Procedure. This means understanding your suppliers and their market dynamics, and working with them to ensure acceptable parts longevity. The ideal situation is to only deal with suppliers who offer a reasonable promise of longevity. Unfortunately, this is not always practical especially when it comes to the leading-edge technologies that evolve very rapidly.

At this stage the board level supplier can provide valuable engineering and technical input during the integrator's system design and evaluation process. There are usually parts of a system that are fairly unique to the platform or to the military environment. Since there is a thriving, though small, semiconductor supply industry still serving, for example, the needs of specific military interfaces, it is unlikely that these areas of a system design will cause severe obsolescence problems down the line. The vulnerable areas of a system design are those that feed off rapidly-evolving technology streams such as those driven by the desktop, telecommunications or consumer goods. Typically, these products will be processors (or single board computers), graphics, memory and DSP boards. In their native market environments these technologies can be expected to have life spans of 1 to 3 years. This

Paper presented at the RTO SCI Symposium on "Strategies to Mitigate Obsolescence in Defense Systems Using Commercial Components", held in Budapest, Hungary, 23-25 October 2000, and published in RTO MP-072.

is unacceptable for the 15+ year lifecycles of major projects. However, these technologies are setting the standards for performance and functionality and have become the targets for new and innovative approaches to product and program lifecycle management.

Lifecycle Management, Two Options: There are still only 2 basic philosophies for program lifecycle management. These can usually be developed into hybrids if necessary to suit the individual program's needs:

Traditional: Freezing the design at the end of the EMD phase is the traditional strategy for dealing with continuity of design and obsolescence. This offers many advantages with respect to control and total interchangeability throughout the program but has serious disadvantages in today's environment.

Advantages:

- Total design control is achieved.
- Modules of a like kind are fully interchangeable.
- The performance of the system is totally predictable.

Disadvantages:

- The design is fixed and therefore inflexible when the time comes to introduce a new feature or capability.
- Some components will go obsolete between the time of EMD, LRIP and full Production with no funding source available for their procurement. It is unusual for funding to be available at EMD or LRIP to buy the full program lifecycle requirements (5 year production plus 15 year support).
- Systematic failure of one single part can make the whole system vulnerable to its effect.
- By the time full production status is achieved the technology is often outdated and does not meet the then current performance standards.

Traditional long term program support requires a Supplier Program Management infrastructure to handle parts control, redesign as required (either device substitution, replacement with ASIC or total product redesign) and long term inventory management. Tailored lifetime sustainment programs need to be created to meet the ongoing needs of specific programs. Despite the care placed upon component management, too many programs are getting trapped into maintenance philosophies that are at the mercy of single-sourced components, many of which are already obsolete. O&M budgets can be used for program sustainment through the redesign of assemblies using newer parts to mitigate against obsolescence, but the wheel will inevitably turn again and no advantage is achieved in terms of either enhanced capability or performance. This is spending just to stand still – no improvement in the performance or functionality of the equipment will be gained unless a major redesign is undertaken, which may even exceed the cost of the original procurement.

Technology Insertion: An alternate approach that is developing into an industry standard is Open Architecture, Functional Partitioning and Technology Insertion. This three-cornered strategy can be used to define the future lifecycle requirements of a system:

Open Architecture: In this case, based on the VMEbus, but could be CompactPCI or high speed serial architecture such as Fibre Channel or Firewire. It provides vendor and technology independence plus a long-life backbone architecture that continues to evolve while maintaining backward compatibility.

Functional Partitioning: This involves the designer's use of the modularity afforded by the chosen open architecture to functionally partition the system into a) platform-specifics with long life span and b) technologies with rapid evolution (i.e. SBCs, graphics, DSP and others).

Technology Insertion: This means planning to insert improved technology in batches through the production and support life of the program.

Advantages:

- The system backbone is future-proofed by the extensive commercial interest in the continued growth and development of VMEbus.
- The system can be upgraded to provide greater performance or functionality as the threat changes (unlike proprietary systems with spare slots which always proved to be unusable at an economic price) and finally the cost/performance of the system will improve with time.
- Moore's Law will prevail meaning that the cost of each new generation of product will continue to decrease.

Disadvantages:

- Systems built in batches with different configurations will present some additional logistics overhead in record keeping and inventory
- Recertification of safety-critical functions may be required.

This is the model that many of today's integrators are adopting to protect against future obsolescence. One example is Boeing/GDIS (General Dynamics Information Systems) and the OSCAR (Open Systems Core Avionics Requirement) program which is planning regular insertions of increasingly powerful Single Board Computers (SBCs) into their systems for deployment on AV-8B, F-15 and F/A-18E/F.

Technology Insertion will be supported by many COTS suppliers in future generations of their product line evolution. This requires serious commitment to continuously update and replace vulnerable product lines. This is very different to the single-point solutions that used to be acceptable for the *traditional* controlled development program.

But Technology Insertion cannot just happen. Each new program should evaluate the benefits and make plans to adopt it as a standard from the outset:

- Make control loops independent of processor performance.
- Never hand-optimize code for performance. Make the application independent of hardware specifics - use middleware to abstract any hardware features.
- Further abstraction can make the application independent of processor type - will require an excess of performance in all situations.
- Plan for the use of the increased capability offered by technology insertion.

Program Considerations: The lifecycle management strategy chosen depends upon the nature of the program: the size of the production run, the length of the full production cycle, the anticipated lifespan, the intended maintenance philosophy and so on. As an example, a low volume program with a relatively short timespan from the introduction of the first unit to the delivery of the final unit can often live within the anticipated *product* lifecycle of the chosen supplier. In this case it is likely that all units can be identical and that spares for the deployed lifetime of the program can be procured at the same time as the production units. This would be a candidate for the consideration of the traditional methods of management. But the downside must not be ignored: once the system is fielded its functionality and performance is fixed for its entire lifecycle, no ability to react to developing countermeasures, or changes in politics, or strategic redeployment.

Consider, however, an alternative scenario which is typical of a major vetronics (vehicle electronics) or avionics procurement program. In this case there is often a lag between ATD, LRIP and EMD phase as field trials and exercises are used to shake down the final performance envelope and functional requirements. A typical production program might encompass 1,000 vehicles or more spread over a 15 year period. Look at the M1A2 Main Battle Tank, Eurofighter Typhoon, F-16 or F/A-18 programs. Translate that into buying power, for example, for microprocessors. Even if each platform had 50 processors of the same type distributed among its various subsystems, that's only 5,000 pieces per year. Not enough to capture the attention of today's microprocessor manufacturers.

The 10 year production period itself is incompatible with today's fast paced technology turnover: the desktop PC is barely 10 years old and look how that has changed. This is a prime example of where there has to be a series of technology insertions through the production life just to ensure continuity of supply. In this case the program will be divided into a number of tranches or blocks, each representing a 3 to 5 year production standard. Using technology insertion without a major rewrite and recertification of the platform at each step is the obvious solution (see Figure 1). Each new block should also be cheaper than the previous – driven by Moore's law.

Technology Refresh: This is a derivative of Technology Insertion. In the previous example of a large production program, every new technology step is made 100% backwardly compatible with the previous so that older technology can be refreshed by swapping out the old for new whenever maintenance action allows. Technology refresh requires that the supplier is very strict about configuration management to guarantee this swap-out capability through the inclusion of the inevitable minor changes over a product's life.

Future Directions for COTS Vendors: Technology Insertion is the strategy that COTS suppliers will support through future generations of their product lines. This requires a commitment to continuously update and replace. There is a very big difference between ***program*** lifecycles and COTS ***product*** lifecycles. A COTS product has a lifecycle much like any other commercial product (i.e. design and development, introduction and capture of design wins, full-scale production, maturity and finally retirement) but with extended timescales.

Product Lifecycle Planning: COTS suppliers today must preplan their products' lifecycles to guard against obsolescence – very often components become obsolete or unobtainable in the very early stages, while the product is still capturing new design wins. Lifetime buys are often the only way to guard against obsolescence, yet how can the supplier estimate the eventual requirements for full scale production and lifetime support this early in the cycle? This issue was not considered seriously enough by the procuring authorities in the changeover to COTS-based procurement. COTS products will go obsolete during the development timescales of a program, yet there is no funding provision available to support the supply base. The only way for the supplier to protect his investment is to preplan for a minimum lifespan, a minimum production volume requirement *and* the introduction of a replacement product (for technology insertion) as early as possible. In this way the integrator and end-user are assured of a continuous stream of evolving yet functionally compatible products. A reasonable timespan today for a 'hot'

product is 5 years from design and development to maturity.

Programs should ideally aim to be in-phase with their chosen supplier's *product* lifecycle. Suppliers must advise their customers of a product's relative position on its lifecycle curve – the maximum benefit can only be obtained when full scale program production coincides with full scale product production. Suppliers today are learning to share these product lifecycle curves and their future roadmaps with their customers to everyone's benefit.

COTS product lifecycle management is still very much in a state of flux and only part of the way up the learning curve. Traditional program requirements cannot be abandoned overnight, so the ideal is to be able to support both the old and the new during a long period of transition. Many of today's COTS VME suppliers do not appreciate the need for either strategy, usually following technology curves with little regard for the program lifecycle. Even though the root cause of rapid component obsolescence is outside of our direct control, there is much that can be done in partnership, between supplier, integrator and end-user to mitigate the effects. Reviewing the overall system architecture and designing for Technology Insertion, hardware abstraction and program/product synchronism hold great promise as methodologies for the future.

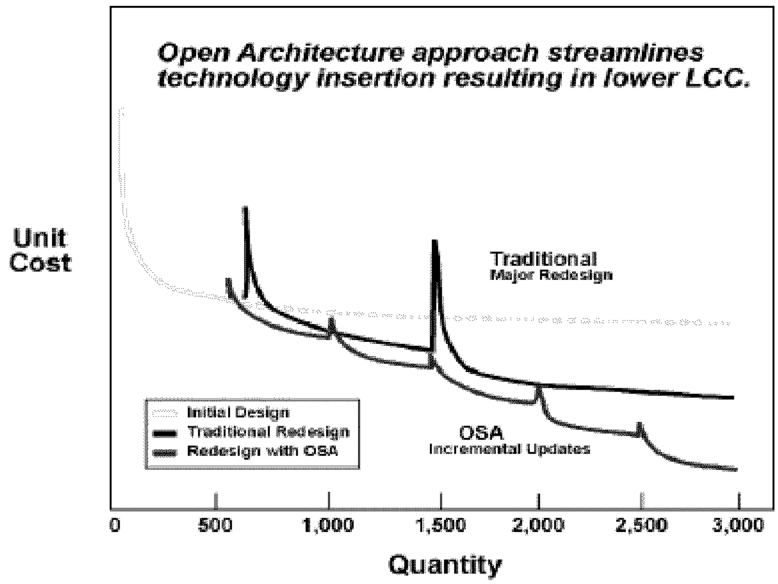

Figure 1: Cost curve of large program based on regular technology insertion

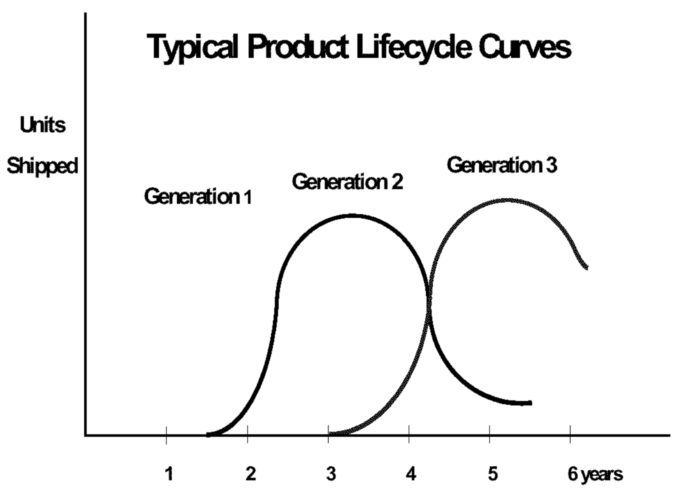

Figure 2: Product Lifecycle curves